TASK ANALYSIS FOR WEAPONS SYSTEMS TESTERS: SHORTCUT TO PAYDIRT IN INFLATIONARY TIMES

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The principal effects of inflation on testing of new weapon systems are to compress schedules and thereby reduce the range and scope of system performance which can be assessed. Test planners today must analyze system performance goals and system design and then predict those few areas where testing is most likely to pay off. Testing conducted only in accordance with these predictions can fail to detect significant problems which will show up when the system is eventually fielded. A new approach to conducting task analysis may provide better indication to test designers of where to anticipate problems and, hence, where to apply scarce testing resources. This approach was developed by a tri-service committee of human factors practitioners, and its concepts won an 80% indorsement of other practitioners in government and industry who responded to a questionnaire.

While the battles of consumers against inflation may gain the most media attention, the pernicious effects of inflation are felt as well by weapon system testers. Most frequently these effects are felt on test schedules, in which such budget contraints as "number of rounds of ammunition available" dictate shorter and smaller tests. Test planners are thus faced with the dilemma of whether to reduce the sample size on which important generalizations are to be based or to eliminate whole subtests. When this dilemma is resolved in favor of the statisticians, one of the first subtests to be cancelled is often that of human factors. Historical grounds for this decision appear to include the perceptions that: (1) no Army system has ever been cancelled solely for human factors reasons, (2) the legendary ingenuity of the American soldier will enable him to overcome or at least compensate for disadvantageous design of equipment, and (3) if the electrical and mechanical subsystems can be made to operate with satisfactory reliability, the whole system is probably good enough to go to the field.

There is growing evidence today that those grounds are being undermined. Human factors deficiencies were prominent among the reasons for Congressional cancellation of the Family of Military Engineering Construction Equipment (FAMECE) project, and the prestigous Kerwin and Blanchard report Man-Machine Interface - A Growing Crisis began, "The US Army has a major man-machine interface problem... The problem is severe and will continue to get worse" (p. 1). Thus, at a time when inflation is exposing testing in general and human factors testing in particular to severe cuts or elimination altogether, the criticality of the man-machine interface is increasing. Prudent test planners are today therefore casting about for more efficient means of determining which areas of system testing are likely to have the highest payoff in terms of testing resources invested.

Human factors practitioners (particularly within the Army) have provided ample guidance:

(1) A general life cycle system management model showing the integration of human factors and identifying test and evaluation activities was published in 1980 (Burt, et. al., 1980).

(2) A detailed guide for gathering and analyzing human performance data during developmental testing was issued by the USA Human Engineering Laboratory in 1976 (Berson and Crooks, 1976).

(3) A workbook and a handbook for assessing human performance during operational testing (known as HRTES) were developed by the US Army Research Institute (Kaplan, et. al. 1980).

Although each of those documents has been well received in the professional community, there remains one persistent problem whose solution has eluded the human factors and training community for years and is a necessary prerequisite to efficient determination of high payoff areas for investment of testing resources. That problem is determining and then documenting what the humans in the system have to do (and, therefore, what training they have to receive) to make it work properly. The means most often used for this undertaking is <u>task analysis</u>.

Task analysis is of course not new, and its origins may lie with the 1898 work of Frederick Taylor at the Midvale Steel Company. A paper by Hays (in press) contains a recent review of the status of task analysis, and another by Berry (1979) contains a succinct summary of the problem:

> Modeling of a human-machine system for whatever purpose, requires that all significant events occurring in the system be described. Task analysis, standard in the repertoire of the human factors engineer, is the technique generally used to describe the activities performed by the human components, or operators. Unfortunately, there is no agreement on the vocabulary or structure to be used in making these descriptions.
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> Within the past 25 years, at least a dozen task classification schemes, or taxonomies, have been proposed. Even definition of the term task is not universally agreed upon, and this definition is critical because it strongly influences the terms, units and general flavor of the final taxonomy (p. 1).

The difficulties with task analysis are well-known to developers of military systems. "Happy hour" conversations often contain stories of defective task analyses, but virtue alone is not enough: during the late 1960s and early 1970s there was a joint German-American development program for a main battle tank. The tank analysis for that system when delivered was 32-inches thick and no one was able to use it (Brogan et. al, 1981, p. 262). Attempts were begun in the late 1970s in the Department of Defense to solve the problem of task analysis. As General Becton explained the problem to the Army's Vice Chief of Staff,

> A proper basis for both human engineering and human factors to pursue their goals is a task analysis. This is an analysis of those specific tasks an operator must perform to operate the system. A valid task analysis provides a logical basis for human engineering design, training program development, training device requirements, and other management considerations such as SQTs and MOS prerequisites. Too often in the development of Army equipment systems, task analyses are not done or are done incompletely. This is a primarily because no military standard currently exists for task analysis, the users of task analysis information have different requirements, multiple formats are used, and the task analysis must be called out as a deliverable data item to be performed (pp. 1-2).

In General Becton's view, what was needed was a military solution to a technological problem.

An intrepid group of military and civilian trainers, testers and human factors specialists drawn from all three armed services began work on the problem in late 1978. By June of 1979 the group (officially designated as the Test and Evaluation Subgroup of the Department of Defense Human Factors Engineering Technical Advisory Group, but more commonly known as the "T&E SubTAG") had reviewed the task analysis programs in all three services, developed its own task taxonomy (see Figure 1),

Mission: What the man-machine system is supposed to accomplish.

Scenario/conditions: Categories of particular factors or constraints under which the system will be expected to operate and be maintained.

Function: A broad category of activity performed by a man-machine system.

Job: The combination of all human performance required for operation and maintenance of one personnel position in a system.

Duty: A set of operationally-related tasks within a given job.

Task: A composite of related activities (perceptions, decisions, and responses) performed for an immediate purpose, written in operator/maintainer language.

Subtask: Activities (perceptions, decisions and responses) which fulfill a portion of the immediate purpose within a task.

Task Element: The smallest logically and reasonably definable unit of behavior required in completing a task or sub-task.

Figure 1. Task Taxonomy from Proposed Military Standard

and outlined a proposed military standard on task analysis (Miles, 1979). A questionnaire was subsequently developed at Edwards AFB, California and sent by name to over a hundred practitioners of human factors and training in government and industry to obtain their reactions to both the proposed taxonomy and the idea of having a military standard serve as arbitrament in this area. To the utter astonishment of the subTAG, more than 80% of the survey respondents agreed with the proposal (which may be an indication that people other than Army generals are tired of chaos in this area). Some minor revisions were then made to the conceptual scheme, and the draft military standard was prepared (Zavala, 1980).

The drafters of the standard had two innovative goals. First, they wanted to use the same task data base for all of the specialty programs (design, training, test and evaluation, manning and workload) which traditionally have required task analysis. This was both for purposes of economy (it's hard enough to get a project manager to buy one task analysis -- let alone five) as well as the promotion of coordination among the various specialists concerned with aspects of personnel and training. To accomplish that goal, they established two resevoirs of data -- "task inventory" which is rigidly controlled by the task taxonomy, and "supporting data" which is everything else in whatever format that may be needed to insure the accuracy or validity of the task analysis. Second, they tried to reach a new height of specificity and flexibility -- the former so that a contractor would know with precision in every case what the desired task analysis should look like, and the latter to give the government maximum freedom in terms of level of detail while still preserving all of the controls inherent in the proposed standard. This was accomplished in two primary ways: (1) by requiring that every task analysis include two specific levels in the task inventory ("job" and "task") and (2) by prescribing output format but not process. It was reasoned that, with these requirements, both gross and detailed task analyses could be obtained from the same data base for the same system (the latter by adding more of the optional levels of the taxonomy) and that two entirely different systems (e.g., a rifle and a jet aircraft) could still use the same conceptual model of task analysis. A schematic of this model is shown in Figure 2. In this model (and in the draft standard) both the input (at least the task inventory portion) and the output (shown as "Data Item Descriptions" on DD Forms 1664) are carefully prescribed; the process called "task analysis" is not. Therefore the government planner may direct that the contractor use anything from a stubby-pencil manual method to one of the sophisticated ADP-assisted methods such as MOAT (see Helm and Donnell, 1979) -- or even some new technique invented after the standard was written.

Use of this standard should be particularly helpful to testers of military systems. Among the recommendations of Generals Kerwin and Blanchard was "Manpower and skill level specifications and human performance requirements must be developed, stated and used to the same degree materiel specifications have been in the past" (Kerwin and Blanchard, 1980, p. 7). Means for implementing this recommendation were proposed by Kaplan and Crooks (1980) based on integrating the draft task analysis standard with their earlier efforts on HRTES. In those projects where that recommendation is in fact implemented, objective, verifiable human performance criteria will exist in requirements documents which can easily be translated into test design plans and then into detailed test plans.

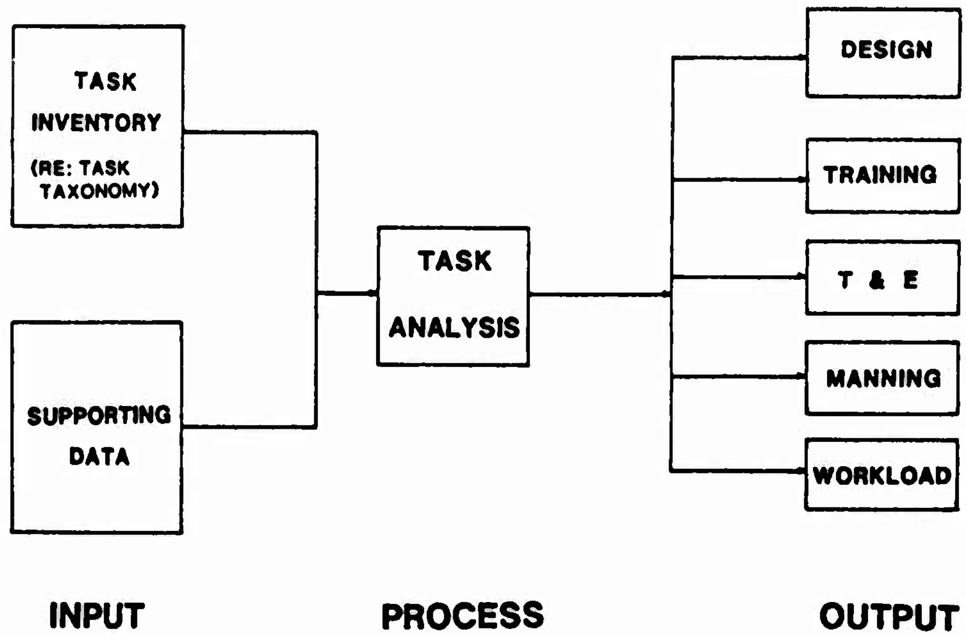

FIGURE 2. SCHEMATIC OF TASK ANALYSIS.

Summary

The draft military standard on task analysis was created to bring both order and standardization to the process of describing and documenting what the humans in a military system are required to do to make it function properly. Its use permits testers of military systems to identify quickly those human performance criteria considered of primary importance in obtaining the forecast level of system effectiveness.

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